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A manual of military surgery - Chapter II: Gunshot wounds

CHAPTER II.

GUN-SHOT WOUNDS.

[This essay is principally a condensation from a recent contribution by Professor Thomas Longmore to Holmes's System of Surgery. It is so admirable in itself, that it has been accepted with but very slight additions or alterations.]

Gun-Shot Wounds.—Wounds by fire-arms are, properly speaking, but wounds by contusion.

They have been distinguished from ordinary contusions and contused wounds by reason of the causes which produce them, the particular appearance that they present, the local and general phenomena that they give rise to, the special complications that affect them, the indications that they point out, the ulterior results which flow from them, and, finally, the conditions under which they are habitually observed.

Character of Gun-Shot Wounds.—When a cannon-ball at full speed strikes in direct line a part of the body, it carries away all before it. If the head, chest or abdomen are exposed to the shot, an opening corresponding with the size of the ball is effected, the contiguous viscera are scattered, and life is at once extinguished. If it be part of one of the extremities which is thus removed, the end remaining attached to the body presents a stump with nearly a level surface of darkly-contused, almost pulpified, tissues. The skin and muscles do not retract, as they would had they been divided by incision. Minute particles of bone will be found among the soft tissues on one side, but the portion of the shaft of the bone remaining *in situ* is probably entire.

In ricochet-firing, or in any case where the force of the cannon-shot is partly expended, the extremity, or portion of the trunk, may be equally carried away, but the laceration of the remaining parts of the body will be greater. The surface of the wound will be less even. Muscles will be separated from each other and hang loosely, offering at their divided ends little appearance of vitality; spiculæ of larger size will

probably be found among them, and the shaft may be found shattered and split far above the line of its transverse division. The injury to nerves and vessels may be proportionately higher and greater.

If the speed be still further diminished, so that the projectile becomes what is termed a "spent ball," there will not be a removal of the parts of the body struck, but the external appearances will be limited usually to ecchymosis and tumifaction, without division of surface; or even these may be wanting, notwithstanding the existence of serious internal disorganization.

Should the cannon-ball strike in a slanting direction, the external appearances of the wound will be similar to those just described, according to its velocity; modified only in extent by the degree of obliquity with which the shot is carried into contact with the trunk or extremity wounded.

Large fragments of heavy shell generally produce immense laceration and separation of the parts against which they strike, but do not carry away or grind as round shot. Ordinarily, the line of direction in which they move forms an obtuse angle with the part of the body wounded. When they happen to strike in a more direct line, so as to penetrate, the external wound is mostly much smaller than the fragment itself, from the projectile not having had force enough to destroy the vitality and elasticity of the soft parts through which it enters.

Small projectiles, with force enough to penetrate the body, leave one or more openings; the external appearances of which also vary according to their form and velocity. The appearance of a wound from a rifle-ball, at its highest rate of speed, may be sometimes witnessed in cases of suicide. The muzzle is usually applied beneath the chin. In such a case, a circular hole, without any puckering or inversion of the marginal skin, together with dark discoloration of the integument for several inches round, is observed at the wound of entrance.

When the musket-ball strikes at a distance from the weapon by which it was propelled, but still preserves great velocity, the appearances of the wound are changed. An opening is observed, irregularly circular, with edges generally a little torn, and the whole wound is slightly inverted. There may be darkening of the margin of a livid-purple tinge, from the effects of contusion, or it may be simply dead-like and pale.

Should the ball have passed out, the wound of exit will be probably larger, more torn, with slight eversion of its edges and protrusion of the subcutaneous fat, which is thus rendered visible. These appearances are the more easily recognised, the earlier the wound is examined. They are more obvious if a round musket-ball has caused the injury than when it has been inflicted by a cylindro-conoidal ball. Indeed, with the latter, when it has simply passed through the soft tissues of an extremity of the body at full speed, it is usually very difficult to distinguish by its appearance the wound of entrance from that of exit.

A musket-ball ordinarily causes either one wound, as when, after entering, it lodges, or, as sometimes happens, from its escaping again by the wound of entrance; or two wounds, from making its exit at some point remote from the spot where it entered; but occasionally leads to a greater number of openings. This last result may happen from the ball splitting into two or more portions within the body, and causing so many wounds of exit.

The number of wounds made by one ball may be increased by its traversing two adjoining extremities of the same person, or some distant parts of the body from accidental relative position at the time of the injury.

The two openings made by one ball may hold such a relative situation as to lead to the mistake of their being supposed to be caused by two distinct balls. Length of traverse, and consequent distance between the two openings, parts of the body brought into unusual relations from peculiarities of posture and peculiar deflections of the ball, may be sources of this error.

The appearances of wounds resulting from penetrating missiles of irregular form, as small pieces of shells, musket-balls flattened against stones, and others, differ from those caused by ordinary bullets, in being accompanied with more laceration, according to their length and form. Being usually projected with considerably less force than direct missiles, such projectiles ordinarily lead only to one aperture, that of entrance.

Symptoms of Gun-Shot Wounds: Pain.—A gun-shot wound by a musket-ball is attended with an amount of pain which varies very much in degree, according to the kind of wound, condition of mind, and state of constitution of the

soldier at the time of its infliction. It will sometimes happen in simple flesh wounds, that patients will tell the surgeon they were not aware when they were struck. Sometimes the pain from the shot is described as a sudden smart stroke of a cane; in other instances, as the shock of a heavy, intense blow. Occasionally the pain will be referred to a part not involved in the track of the wound. Immediately after the transit of a ball, the sensibility of the track and parts adjoining is found to be partially numbed, so that examination is borne more readily for a short time after the accident than at any later period. Of course, after re-action sets in, or when inflammation has been established, the pain of the wound is proportionably increased. When a ball does not penetrate, but simply inflicts a contusion, the pain is described to be more severe than where an opening has been made by it.

Shock.—When a bone is shattered, a cavity penetrated, an important viscus wounded, a limb carried away by a round-shot, pain is not so prominent a symptom as the general perturbation and alarm which supervene on the injury. This is generally described as the "shock" of a gun-shot wound. The patient trembles and totters, is pale, complains of being faint, perhaps vomits. His features express anxiety and distress. This emotion is in great measure instinctive; it is sympathy of the whole frame with a part subjected to serious injury, expressed through the nervous system.

As a general rule, the greater the injury, the greater and more persistent is the amount of shock. A rifle-bullet, which splits up a long bone into many longitudinal fragments, inflicts a very much more serious injury than the ordinary fracture effected by the ball from a smooth-bore musket, and the constitutional shock bears like proportion. When a portion of one or both lower extremities is carried away by a cannon-ball, the higher towards the trunk the injury is inflicted, the greater the shock, independent of the loss of blood. The practical experience of every army surgeon teaches him, that where a ball has entered the body, though its course is not otherwise indicated, the continuance of shock is a sufficient evidence that some organ essential to life has been implicated in the injury.

Primary Hemorrhage.—Primary hemorrhage of a serious nature from gun-shot wounds does not often come within the sphere of the surgeon's observations. If hemorrhage occur

from one of the main arteries, it probably proves rapidly fatal. When a part of the body is carried away by round-shot or shell, the arteries are observed to be nearly in the same state as they are found to be in when a limb is torn off by machinery. The lacerated ends of the middle and inner coats are retracted within the outer cellular coat; the calibre of the vessel is diminished, and tapers to a point near the line of division; it becomes plugged within by coagulum; and the cellulo-fibrous investing sheath, and the clot which combines with it, form on the outside an additional support and restraint against hemorrhage. When large arteries are torn across, and their hemorrhage thus spontaneously prevented, they are seldom withdrawn so far but that their ends may be seen protruding and pulsating among the mass of injured structures; yet, though the impulse may appear very powerful, further hemorrhage is rarely met with from such wounds. There is more danger of continued hemorrhage from wounds by pieces of shell, as the arteries are liable to be wounded without complete transverse section of their coats. Primary but indirect hemorrhage, in consequence of a gun-shot injury, usually occurs as a complication of fractured long bones, the sharp points and edges of which, extensively torn up as they now are by conical bullets, are well calculated to cause such injuries.

General Treatment.—When the circumstances of a battle admit of the arrangement, the wounded should receive surgical attention preliminary to their being transported to the regimental or general field hospital in the rear. The provisional treatment should be of the simplest kind, and chiefly directed to the prevention of additional injury during the passage to the hospital, where complete and accurate examination of the nature of the wound can alone be made, and where the patient can remain at rest, after being subjected to the required treatment. The removal of any missiles or foreign bodies which may be readily obvious; the application of a piece of lint to the wound; the arrangement of any available support for a broken limb; protection against dust, cold, or other objectionable circumstances likely to occur in the transit; if shock exist, the administration of a little wine, aromatic ammonia, or other restorative, in water—need little time in their execution, and may prove of great service to the patient. If hemorrhage exist, from injury to a large

vessel, it must, of course, receive the surgeon's *first* and most earnest care. He should not trust to a tourniquet, but secure it at once by ligature.

On arrival at the hospital, the following are the points to be attended to by the surgeon: firstly, examination of the wound, with a view to obtaining a correct knowledge of its nature and extent; secondly, removal of any foreign bodies which may have lodged; thirdly, adjustment of lacerated structures; and fourthly, the application of the primary dressings.

The *diagnosis* should be established as early as possible after arrival at hospital. An examination can then be made with more ease to the patient, and more satisfactorily to the surgeon, than at a later period.

One of the earliest rules for examining a gun-shot wound is to place the patient, as nearly as can be ascertained, in a position similar to that in which he was in relation to the missile, at the time of being struck by it. In almost every instance, the examination will be facilitated by attention to this precept.

When only one opening has been made by a ball, it is to be presumed that it is lodged somewhere in the wound, and search must be made for it accordingly. But even when two openings exist, and evidence is afforded that these are the apertures of entrance and exit of one projectile, examination should still be made to detect the presence of foreign bodies. Portions of clothing, and other harder substances, are not unfrequently carried into a wound by a ball; and, though it, itself, may pass out, these may remain behind, either from being diverted from the straight line of the wound, or from becoming caught and impacted in the fibrous tissue through which the ball has passed. The inspection of the garments worn over the part wounded may often serve as a guide in determining whether foreign bodies have entered or not, and, if so, their kind, and thus save time and trouble in the examination of the wound itself.

Of all instruments for conducting an examination of a gun-shot wound, the finger of the surgeon is the most appropriate. By its means the direction of the wound can be ascertained with least disturbance of the several structures through which it takes its course. The index finger naturally occurs as the most convenient for this employment; but

the opening through the skin is sometimes too contracted to admit its entrance, and in this case the substitution of the little finger will usually answer all the purposes intended. When the finger fails to reach sufficiently far, owing to the depth of the wound, the examination is often facilitated by pressing the soft parts from an opposite direction towards the finger end.

It was formerly the custom to enlarge the external orifice of all gun-shot wounds by incision; and not merely the opening, but the walls of the wound itself, as soon after the injury as possible. This was not done as a means of rendering the examination easier, but as a prophylactic measure. Dilitation was also employed, by tents and various other means, with a view to secure the escape of sloughs and discharges. English surgeons have, however, generally discarded the practice, excepting only in cases where it is required to allow of the extraction of some extraneous body; to secure a wounded artery; to replace parts in their natural situation, as in protrusion of viscera in wounds of the abdomen; or, in short, when anything can be done to the part wounded, after the opening is made, for the present relief of the patient, or the future good arising from it.

It does not happen that it is necessary to enlarge the openings of wounds to remove balls, although a certain amount of constriction of the skin may be expected from the addition of the instrument employed in the extraction; but if much resistance is offered to their passage out, it is better to divide the edges of the fascia and skin to the amount of enlargement required, than to use force. In removing fragments of shells or detached pieces of bone, the fascia and skin have almost invariably to be divided to considerable extent.

When the finger is not sufficiently long to reach the bottom of the wound, even when the soft parts have been approximated by pressure from an opposite direction, and when the lodgment of a projectile is suspected, a long silver probe, that admits of being bent by the hand, if required, is the best substitute. Elastic bougies or catheters are apt to become curled among the soft parts, and do not convey to the sense of touch the same amount of information as metallic instruments do. The probe should be employed with great nicety and ease, for it may inflict injury on vessels or other structures which have escaped from direct contact with the

ball, but have returned, by their elasticity, to the situation from which they had been pushed or drawn aside during its passage. The above directions for examining wounds apply more particularly to such as penetrate the extremities, or extend superficially in other parts of the body. When a missile has entered any of the important cavities, search for it is not to be made, but the surgeon's attention is to be directed to matters of more vital importance, to be hereafter noticed.

Removal of Foreign Bodies.—As soon as the presence of a ball or other foreign body is ascertained, it should be removed. If it be lying within reach from the wound of entrance, it should be extracted through this opening by means of the various instruments advised for this purpose. Instruments of two blades, or scoops, with ordinary hinge action, dilate the track of the wound injuriously before the ball can be grasped by them. The way to the removal of a bullet may often be smoothed by judiciously clearing away the fibres, among which it is lodged, during the examination by the finger; and sometimes, by means of the finger in the wound, and external pressure of the surrounding parts, the projectile may be brought near to the aperture of entrance, so that its extraction is still further facilitated.

Such foreign substances, as pieces of cloth, can usually be brought out by the finger alone, or by pressing them between the finger and a silver probe, inserted for the purpose. Sometimes a long pair of dressing forceps, guided by the finger, is found necessary for effecting this object. Caution must be used in employing forceps, when the foreign substance is out of sight, and of such a quality that the soft tissues may be mistaken for it.

In some instances, when the foreign body has not completely penetrated, but is found lying beneath the skin, away from the wound of entrance, an incision must be made for its extraction. Before using the knife, the substance to be removed should be fixed *in situ*, by pressure on the surrounding parts. In the instance of a round ball, the incision should be carried beyond the length of its diameter; an addition of half a diameter is usually sufficient to admit of the easy extraction of the ball. In removing conical balls, slugs, fragments of shells, stones, and other irregularly shaped bodies, the surgeon cannot be too guarded in arranging that the fragment is drawn away with its long axis in line with the

track of the wound. By proper care in this respect, much injury to adjoining structures may be avoided.

If balls are impacted in bone, as happens in the spongy heads of bones, in bones of the pelvis, and occasionally, though rarely, in other parts of long bones, they should be removed. This can be effected by means of a steel elevator, of convenient size; or, should this fail, from the ball being too firmly impacted, a thin layer of the bone, on one side of the ball, may be gouged away, so that a little purchase may be obtained for the elevator, in effecting its removal. The fact is now fully established, that, although in a few isolated cases, balls remain lodged in bones without sensible inconvenience, in the majority the lodgment leads to such disease of the bony structures as often to entail troublesome abscesses, and, in some instances, eventually to necessitate amputation. The lodgment of balls will not often occur, without extensive fracture in warfare, where rifled arms of such force as the Minnie and Enfield are the chief weapons employed.

Should there be reason for concluding that a ball or other foreign body has lodged, but after manual examination and observation, as well by varied posture of the part of the body supposed to be implicated, as by indications derived from the patient's sensations, effects of pressure or injury to nerves, and all other circumstances which may lead to information, should the site of the lodgment not be ascertained, the search should not be persevered in to the distress of the patient. Neither, although the site of lodgment be ascertained, if extensive incisions are required, or if there is danger of wounding important organs, should the attempts at extraction be continued. Either during the process of suppuration, by some accidental muscular contraction, or by gradual approach towards the surface, its escape may be eventually effected; or, if of a favorable form, and if not in contact with nerve, bone, or other important organ, it may become encysted and remain without causing pain or mischief. Extensive experience has shown that not only is the risk of subsequent ill results greater in those cases where foreign bodies remain lodged than where they have been cut out; but also that the advantages of a second opening for the escape of the necessary sloughs and discharges greatly preponderate over the disadvantages connected with it, as regards the additional extent of injured surface.

Local Treatment.—When a gun-shot wound has been accompanied with much laceration and disturbance of the parts involved in the injury, it is necessary, after the removal of all foreign substances that can be detected, to re-adjust and secure the disjoined structures as nearly as possible in their normal relations to each other. The simplest means—strips of adhesive plaster, light pledgets of moist lint, a linen roller, favorable position of the limb or part of the body wounded—should be adopted for this purpose. Pressure, weight and warmth should be avoided as much as possible in these applications, consistent with the end in view. It must not be forgotten, in thus bringing the parts together, that the purpose is not to obtain union by adhesion, which can not be looked for, but simply to prevent avoidable irritation and malposition of parts, during the subsequent stages of cure by granulation and cicatrization. In all gun-shot wounds much discomfort to the patient is prevented by carefully sponging all blood and clot from the surface adjoining the wound, and by adopting measures to prevent its spreading again in consequence of oozing. This can be readily done with the aid of a little warm water and arrangement when the wound is first dressed, but can only be accomplished with considerable inconvenience after the thin clots have become hard and firmly adherent to the skin.

When the parts of a lacerated gun-shot wound have been brought into apposition, as in simple, penetrating wounds, the only dressing necessary is moistened lint. It should be kept moist either by the renewed application of water dropped upon it, or by preventing evaporation by covering it with oiled silk. The sensations of the patient may be consulted in the selection of either of these; and climate and temperature will be often found to determine the choice. M. Boudens and Dr. Stemeyer have strongly recommended the topical application of ice placed in bladders; others, the continued irrigation of the wound with tepid water. When much local inflammation has set in, and when there is much constitutional fever even without unusual local irritation, the non-evaporating or warm applications will be found to be the most advantageous.

When suppurative action has been fully established, the surgeon must be guided by the general rules applicable to all other such cases. Care must be taken to prevent the accumulation of pus, lest it burrow, and sinuses become estab-

lished; not an unfrequent result of want of sufficient caution in this regard. If much tumefaction of muscular tissues beneath fascia occurs, or abscesses form in them, free incisions should be at once made for their relief. In wounds where the communication between the apertures of entrance and exit is tolerably direct, occasional syringing with tepid water may be useful, by removing discharges and fibres of cloth which may be lying in the course of the wound. Weak astringent solutions are occasionally employed in a similar way, with a view to improving the tone of the exhalants and exciting a more vigorous action in the process of granulation.

The strictest attention to cleanliness and the complete removal of all foul dressings are essentially necessary, not merely for the comfort of the patient, but to prevent the accumulation of noxious effluvia, and also to obviate the access of flies to the wounds. Cloths dipped in weak solutions of creasote or disinfecting fluid, laid over the wound, are found necessary for this purpose when the insects abound in great numbers.*

Constitutional Treatment.—The constitutional treatment in an ordinary gun-shot wound, uncomplicated with injury of bone or structures of first importance, should be very simple. The avoidance of all irregularity in habits tending to excite febrile symptoms or to aggravate local inflammation, attention to the due performance of the excretory functions, and support of the general strength, are chiefly to be considered. Bleeding, with a view to prevent the access of inflammation in such cases, is now never practised. The diet should be nutritious, but not stimulating. A pure fresh atmosphere is a very important ingredient in the means of recovery. If from previous habits of the patient, or from circumstances to which he is unavoidably exposed, the local inflammation has become aggravated—indicated by pain, increased swelling, and redness about the wound—topical depletion, by leeches or cupping, bleeding from the arm, saline and antimonial medicines, and strict rest in the recumbent position, must be had recourse to, the extent being regulated by the circumstances of each case. In instances such as these, when the inflammation has become diffused, the purulent secretion is

* Inf. sambuci has been recently highly recommended, also to paint the ulceration over with a thin layer of honey.

not confined to the track of the wound, but is liable to extend among the areolar connexions of the muscles; and if the cure be protracted, attention will be necessary to prevent the formation of sinuses. If stiffness or contractions result, attempts must be made to counteract them by passive motion and friction, with appropriate liniments; if a tendency to œdema and debility remain in a limb after the wound is healed, the cold water douche will be found to be one of the most efficient topical remedies. In French practice, the administration of perchloride of iron as a tonic, or diluted, as an injection, in wounds threatening to assume an unhealthy character, is very highly praised. It is stated, that under the conjoined employment of this remedy internally and externally, in wounds of a pallid, unhealthy aspect, accompanied by nervous irritability and symptoms of approaching pyæmia, the granulations have assumed a red and healthy appearance, and the general state of health become rapidly favorable.

Gun-Shot Wounds in Special Regions of the Body.

Gun-shot Wounds of the Head.—No injuries met with in war require more earnest observation and caution in their treatment than wounds of the head. The vital importance of the brain; the varied symptoms which accompany the injuries to which this organ may be subjected, directly or indirectly; the difficulty in tracing out their exact causes; the many complications which may arise in consequence of them; the sudden changes in condition which not unfrequently occur without any previous warning; all these circumstances will keep a prudent surgeon, who has charge of such wounds, continually on the alert. Injuries of this class, the most slight in appearance at their onset, not unfrequently prove most grave as they proceed, from encephalitis and its consequences, or from plugging of the sinuses by coagula, leading to coma, paralysis or pyæmia; and the converse sometimes holds good with injuries presenting at first the most threatening aspects, where care is taken to avert these serious results. Mr. Guthrie has laid down as a rule that injuries of the head, of apparently equal extent, are more dangerous on the forehead than on the side or middle portion, and still more so than those on the back part; and that a fracture of the vertex is infinitely less important than one at the base of the cranium.

When the injuries are caused by rifle balls, however, these considerations are rarely of much avail, for the power of injury is such that it can scarcely ever be confined to the immediate neighborhood of the part directly struck.

Wounds of the Scalp and Pericranium.—These wounds are usually inflicted by projectiles which are brought into contact at a very acute angle, so that little direct injury to the brain or its membranes is inflicted, and the surgeon's attention need only be directed to the same considerations as must occur in any contused wounds of the scalp from other causes than gun-shot. But, even in these accidents, though appearing to be simple flesh wounds, serious cerebral concussion and other lesions are occasionally met with. The usual stupor and other signs of concussion may be very evanescent, or may last for several days, disappearing gradually and wholly, or entailing subsequent evils at more or less remote periods. It must not be forgotten that when the pericranium is removed by a musket ball, however superficial the injury may seem, there is always a certain degree of injury and bruising to the bone from which it is torn, and necessary laceration of the vessels which inosculate with the nutritive capillaries of the diploe, and through them of the vessels of the meninges with which they are connected. The injury to this vascular system almost invariably leads to necrosis of the portion of the skull from which the coverings are carried away; and, sometimes, even when the pericranium is not torn off, sufficient injury is inflicted to lead to a like result. The death of the bone is generally limited to a thin layer of the outer table, which in due time exfoliates. The injury to the vessels ramifying between the inner surface of the cranium and dura mater, may lead to serious results. There may be rupture of a sinus, leading to compression, or fatal results may ensue from inflammation and suppuration.

Treatment.—The treatment of an ordinary gun-shot wound of the scalp should be very simple. Cleansing the surface of the wound, removing the hair from its neighborhood for the easier application of dressings, lint moistened with clean water, very spare diet, and careful regulation of the excretions, are the only requirements in most cases. The patient must be closely watched, so that measures may be taken to counteract inflammatory symtoms in their earliest stages. Even after one of these wounds has healed, and the patient, to all

appearance, has quite recovered, it is necessary to enjoin continued abstinence from excesses of all kinds. Instances are frequently quoted where intoxication, a long time after the date of injury, has induced symptoms of apoplexy and death.

Wounds Complicated with Fracture, but without Depression on the Cerebrum.—In these injuries there may be a simple furrowing of the outer table, without injury to the inner; or there may be fissure extending to a greater or less degree of length, or radiating in several lines; or both tables may be comminuted in the line the ball has traversed in such small portions, that they lie loose on the dura mater, without much alteration in the general outline of the cranial curve. The chief and only means, in many cases, of concluding that no depression upon the cerebrum has taken place, is the absence of the usual symptoms of compression; for it is well known that simple observation of the injury to the outer table, whether by sight or touch, will, by no means, necessarily lead to a knowledge of the amount of injury, or change of position, in the inner table.

When simple removal of a portion of the outer surface of the skull has been caused by the passage of the ball or other missile, the wound will sometimes heal, under judicious treatment, without any untoward symptom. A layer of the exposed surface of bone will probably exfoliate, and the wound granulate and become closed without further trouble. But such injuries, for reasons before named, are very likely to be followed by inflammation, and not improbably by abscess, between the internal table and dura mater; and further, as a consequence of the vascular supply being stopped, and perhaps also partly from the effect of the original contusion, by necrosis of the inner table itself. Care must be taken not to mistake one of these injuries for a depressed fracture, as it is not unlikely to happen when the excavation effected by the projectile is rather deep, and the edges of the bone bordering the excavation are sharp.

Fissured fractures, when the fissure extends through the skull, usually result from injuries by shell. The passage of a ball may fracture and very slightly depress a portion of the outer table of the cranium, and then the line of fracture will very closely simulate fissured fracture, extending through both tables, and the diagnosis between them be excessively doubtful. When fissured fracture exists, the distance to

which it may be prolonged is often quite unindicated by symptoms, and its extent is very uncertain. Fissures often extend to long distances. They may occur at a part remote from the spot directly injured. Fissured fracture of the inner table may also occur from the action of a ball, without external evidence of the fracture. The cases where comminution has resulted from the track of a ball across the skull, generally present less unfavorable results than those where a single fissured fracture, extending through both tables, exists. The small, loose fragments can be removed, and if the dura mater be intact, the case, with proper care to prevent inflammatory action, may not improbably be attended with a favorable recovery.

Wounds Complicated with Fracture and Depression on the Cerebrum.—Such wounds are most serious, and the prognosis must be very unfavorable. They must not be judged of by comparison with cases of fracture, with depression, caused by such injuries as are usually met with in civil practice. The severe concussion of the whole osseous sphere by the stroke of the projectile, the bruising and injury to the bony texture immediately surrounding the spot against which it has directly impinged, as well as the contusion of the external soft parts, so that the wound cannot close by the adhesive process, constitute very important differences between gun-shot injuries, on the one side, and others caused by instruments impelled by muscular force on the other. So, also, the injury to the brain within, and its investments, is proportionably greater in such injuries from gun-shot. The experience of the Crimean campaign shows, that when these injuries occurred in a severe form, they invariably proved fatal.

With Penetration of the Cerebrum.—It is obvious that when a projectile has power not only to fracture, but also to penetrate the cranium, it will rarely be arrested in its progress near the wound of entrance. Either splinters of bone, or the ball, or a portion of it, will be carried through the membranes into the cerebral mass. Sometimes a ball, if not making its exit by a second opening in the cranium, will lodge at the point of the cerebral substance opposite to that of its place of entrance; but the course a projectile may follow within the cranium is very uncertain.

Treatment.—Formerly, a gun-shot wound of the head was

supposed to be in itself a sufficient indication for the use of the trephine. Modern surgeons, however, generally have made use of the trephine only when there was reason for concluding that depressed bone was leading to *permanent* interruption of cerebral function, or that an abscess had formed within reach, and was capable of evacuation. Preventive trephining has been proved to be useless, as well as dangerous, and is no longer an admissible operation. The tendency of the most recent experience has been to limit the practice of trephining to the narrowest sphere, and when the great difficulty of making accurate diagnosis in these cases considered—whether as to the distinguishing signs of compression; the precise seat of the cause, if the compression exist; the space over which the cause, when ascertained, may extend; its persistent or temporary character; its complications; and certain dangers connected with the operation itself—no wonder need be excited that this tendency should exist. Besides, the numerous cases which have been noted where bone has evidently been depressed, but the brain has accommodated itself to the pressure without serious disability being caused, or when compression from effusion has been removed by absorption, under proper constitutional treatment, are farther causes of hesitation in respect to trephining. Where irregular edges, points or pieces of bone, are forced down and penetrate—not merely pressing upon—the cerebral substance, or when abscess manifestly exist in any known site, or a foreign substance has lodged near the surface, and relief cannot be afforded by the wound, trephining may be resorted to for the purpose; but the application of the operation, even in these cases, will be very much limited, if certainty of diagnosis be insisted upon. In all other cases, it seems now generally admitted, that much harm will be avoided, and benefit more probably effected, by employing long-continued constitutional treatment, viz: all the means necessary for controlling or preventing the diffusion of inflammation over the surface of the brain and its membranes—the most careful regimen, very spare diet, strict rest, calomel and antimonials, occasional purgatives, cold applications locally, so applied as to exclude the air from the wound, and free depletion by venesection, in case of inflammatory symptoms arising. Similar remarks will apply in case of lodgment of a projectile within the brain. If the site of its lodgment is obvious, it should be removed with as little dis-

turbance as possible; but trephining for its extraction on simple inference is unwarrantable.

Gun-shot Wounds of the Spine.—Gun-shot wounds of the spine are closely associated with similar injuries of the hea. In both, classes corresponding considerations must be entertained by the surgeon in reference to the important nerve-structures, with their membranes, which are likely to be involved in the injury to their osseous envelope; in both, the effects of concussion, compression, laceration of substance, or subsequent inflammatory action, chiefly attract attention.

In injuries of the vertebral column and spinal cord occurin3 in military practice, the mischief is usually so complicated and extensive, and the medulla itself so bruised, that the cases must be very rare indeed in which the operation of trephining, if justifiable in any case, can offer the slightest prospect of benefit.

Gun-shot Wounds of the Face.—Wounds of the face from gunshot, grape, and small fragments of shell are usually more distressing from the deformity they occasion than dangerous to life. The absence of vital organs, the natural divisions among the bones, and their comparatively soft structure rendering them less liable to extensive splitting; the copious vascular reticulation and supply rendering necrosis so much less likely, and repair so much easier than in other bones; the limited amount of space occupied by the osseous structure between their respective periosteal investments, and the opportunities from the number of cavities and passages connected with this region for the escape of discharges—lead to this result. On the other hand, the vascularity of this region leads to danger both of primary, and especial secondary, hemorrhage—a circumstance which in all deep wounds of this region must be looked for as a not improbable complication. The other complications of these gun-shot wounds are lesions of the organs of special sense, injury to the base of the skull, paralysis from injury to nerves. Wounds of glands, their ducts, and of the lachrymal apparatus.

Treatment.—In the treatment of gun-shot wounds of the face where the bones are splintered and torn, the surgeon should always retain and replace as many of the broken portions as possible. It is often surprising how small connexions with neighboring soft parts will suffice to maintain vitality and lead to restored union in this region. In case a ball has

to be removed, when practicable, it should always be extracted through the mouth. Great care should be used, both by position and attention to dressing, to prevent the swallowing of the secretions from wounds of these parts, as it may lead to great constitutional irritation, and fever of a low typhoid and fatal character. Should secondary hemorrhage supervene from the deep branches in this region, it will be necessary to ligate the main trunk, the local method of ligation not being applicable from the difficulty experienced in reaching the vessels.

Gun-shot Wounds of the Chest.—Gun-shot wounds of the chest may conveniently be divided into two classes, viz: *non-penetrating* and *penetrating*.

Non-penetrating wounds become subdivided into simple contused wounds of the soft parieties; contused and lacerated wounds; the same accompanied with injury to bones or cartilage; and lastly, those complicated with lesion of some of the contents of the chest, the pleura remaining unopened, or, if opened, without a superficial wound.

Penetrating wounds may exist without wound, or with wounds of one or more of the viscera of this cavity. Among the more serious complications with which the latter may be accompanied is the lodgment of the projectile or other foreign bodies, as of fragments of bone, within the chest. As wounds of the heart and great vessels are almost invariably at once fatal, and as the organs of respiration occupy the greater part of the cavity of this region, it is in reference to the latter that the treatment of chest wounds is chiefly concerned.

Non-penetrating Wounds.—Of the simpler wounds, in which the soft parieties only are involved, little need be observed, excepting that the healing process is often prolonged by the natural movements of the ribs to which the wounded structures are attached, especially when the ball has taken a circuitous course beneath the skin, and that the surgeon must be on his guard to watch for pleuritis arising as an occasional consequence of these injuries. When the force has been great, as when fragments of shell or rifle balls strike at full speed against a man's breast-plate, not only may troublesome superficial abscesses and sinuses follow, but the lungs may have been compressed and ecchymosed at the time of the injury, and hæmoptysis be one of the symptoms presented.

When the projectile has been of large size, although no

opening of the parieties or fracture exists, death sometimes ensues by suffocation, as the direct result of pulmonary engorgement. The danger of pleuritis or pneumonia will, when the injury has been so severe as to cause division of bone or cartilage, and the subsequent suppuration and process of exfoliation, will not unfrequently prove very tedious and troublesome. Although the pleura has not been opened, the lung may be lacerated, either by the force of contusion, or, as in a case recorded by Dr. Macleod, by the edges of the fractured ribs, which may afterwards return to their normal relative positions, so as to leave no indication during life of the means by which the lung had been wounded. Such an injury would be rendered much more probable by the existence of old adhesions, connecting the pulmonary and costal pleuræ opposite to the site of injury.

Notwithstanding a projectile has not penetrated the parieties of the chest, a pleural cavity may be opened, as in injuries from other causes, and the lung wounded by the sharp edges of fractured ribs. This will be indicated by emphysema, pneumothorax, hæmoptysis, probably signs of internal hemorrhage and inflammation. Such wounds will generally be the result of injuries from fragments of shell.

Penetrating Wounds.—These wounds, especially when the lung is perforated or the projectile lodges, are necessarily exceedingly dangerous. Fatal consequences are to be feared, either from hemorrhage, leading to exhaustion or suffocation; from inflammation of the pulmonary structure or pleuræ; from irritative fever accompanying profuse discharges; or from fluid accumulations in one or both of the pleural sacs.

In gun-shot injuries a penetrating wound of the chest is, in most instances, readily obvious to the sense of sight or touch; but it will be found by no means easy always to decide whether a lung has been penetrated or otherwise. The train of symptoms usually described as characterizing wounds of the chest must not be expected to be all constantly present; they are each liable to be modified by a great variety of circumstances, and may each severally exist in penetrating wounds of the chest where the lung has escaped perforation. Nor is it always easy to determine whether the ball has lodged or not; or, the ball having passed through, whether fragments of bone, or other substances, have remained behind. When the chest has been opened by a projectile, the following signs may

be expected in addition to the external physical evidences of the injury: a certain amount of constitutional shock, collapse from loss of blood, and, if the lung be wounded, effusion into the pleural cavity, hæmoptysis, dyspnœa, and an exsanguine appearance. These will generally, but not invariably, be followed, after twenty-four hours or later, by the usual signs of inflammation in some of the structures injured.

The shock of penetrating wounds of the chest, apart from the collapse consequent on hemorrhage, is not generally so great as happens in extensive injuries to the extremities, or in penetrating wounds of the abdomen. There is often much more shock where a ball has not penetrated; but, having met with something to oppose its course, has nevertheless inflicted a violent percussion of the whole chest and its contents.

When loss of blood occurs without the lung being wounded, the hemorrhage is probably proceeding from a wound of one of the intercostal arteries, which has been torn by the sharp ends of fractured bone. Serious hemorrhage, however, is exceedingly rare from vessels external to the cavity of the chest.

When blood is effused in any large quantity into the pleural sac—as indicated by the exsanguine appearance of the patient, increasing dyspnœa, occasional hæmoptysis, and the stethoscopic signs of auscultation—the inference is that the lung has been opened, and that it is from its structure the blood is flowing. The amount of hemorrhage in wounds of the lung will greatly vary according to the direction of the track of the ball; for the large vessels cannot here glide away from the action of the projectile, as they may in the neck or extremities of the body. Wounds, therefore, near the root of each lung, where the pulmonary arteries and veins are largest, are attended with the greatest amount of hemorrhage; and as coagula can hardly form sufficiently to suppress the flow of blood, are generally fatal.

Hæmoptysis indicates injury to the lung, but does not give assurance that this organ has been penetrated. It generally accompanies gun-shot wounds of the lung in a greater or less degree, no doubt always when a bronchial tube of large size is penetrated; but, as may be ascertained by careful perusal of recorded cases, is sometimes wholly absent, even though the patient may be troubled by cough.

Dyspnœa is a frequent accompaniment of wounds pene-

trating the lung, but not as a constant symptom before inflammatory action has set in. When dyspnœa is great in the early period, it will often be found to depend upon the injuries to the parieties, and to the pain caused on taking a full inspiration; as a sign of subsequent mischief in the progress of the case, it is, of course, very constantly present. It is now known that the opening of the pleura does not necessarily induce collapse of the lung, even though unfettered by adhesions during life. It was formerly supposed that the escape of air by the wound was a sufficient proof that the lung had been opened by the projectile; but it is evident that it is not so, as the air may enter by the wound and be forced out again by the expansion of the lung in inspiration, or by the action of the chest on expiration. If air and frothy mucus, with blood, as noticed in one of the cases recorded in the Crimean campaign, escape by the wound, there can be no doubt of the nature of the injury. Emphysema is not common in penetrating gun-shot wounds, but occasionally happens. The free opening generally made by the projectile sufficiently explains the fact.

Treatment.—The object of the surgeon's care must be, in the first place, to arrest hemorrhage; afterwards, to remove pieces or jagged projections of bone, or any other sources of local irritation; and to adopt means to prevent interference with the natural process of cure which takes place by adhesion of the opposite pleural surfaces near the wound in the first instance, and subsequently by cicatrisation of the wound itself. Although the shock may happen to be considerable, attempts to rally the patient, if any be made, should be conducted very cautiously; the prolongation of the depressed condition may be valuable in enabling the injured structures to assume the necessary state for preventing hemorrhage. Hemorrhage from vessels belonging to the costal parieties should be arrested by ligation, as in other parts, if the source from which it proceeds can be ascertained, and if the flow of blood be so free as not to be controlled by the ordinary styptics. Operative interference of this kind is chiefly called for on account of secondary, not primary, hemorrhage.

Hemorrhage from the lung itself must be treated on the general principles adopted in all such cases; the application of cold to the chest, perfect quiet, the administration of opium, and, if the patient be sufficiently strong, bleeding from

a large vein until *syncope* supervenes. When blood has accumulated in any large quantity, and the patient is much oppressed, the wound should be enlarged, if necessary, so as, with the assistance of proper position, to facilitate its escape. If the effused blood, from the situation of the wound, cannot be thus evacuated, and the patient is in danger of suffocation, then the performance of paracentesis, as directed for the relief of empyema, must be resorted to.

The extensive bleedings formerly recommended in all penetrating gun-shot wounds of the chest, are now practised with much greater limitations; indeed, should never be employed simply with a view to prevent mischief from arising. Venesection, carried to a great extent, does harm by lessening the restorative powers of the frame It appears to interrupt the process of adhesion between the pleural surfaces and the steps taken by nature to repair the existing mischief, while it leads the injured structures into a condition favorable for gangrene, or encourages the formation of ill-conditioned purulent effusions. When inflammation has arisen, venesection may be joined with other means to control its excessive action, and to give relief, which it certainly does, to the patient; and when hemorrhage is manifestly going on internally, it may be practised with a view of draining the blood from the system and more speedily inducing faintness, to give an opportunity to the pulmonic vessels to become closed; but, even when thus applied, the general state of the patient will not be unconsidered by a judicious surgeon, nor caution neglected lest the venesection cause him to sink more rapidly from the additional shock to the system and abstraction of restorative force. Taking away blood certainly does not prevent pneumonia from supervening, but occasionally seems to give the inflammation, when it arises, more power over the weakened structures, or even to cause it to be accompanied by typhoid symptoms.

To remove splinters of bone, and re-adjust indented portions of the ribs, the finger should be introduced into the wound, and care taken that in so doing no pieces of cloth or fragments be separated and projected into the pleural sac. Notice must, at the same time, be taken of any bleeding vessel requiring to be secured. A pledget of lint should be laid on the wound, and a broad bandage placed around the chest, just tight enough to support the ribs and in some degree to restrain their movements, but with an opening over each wound large enough to

permit the ready access of the surgeon to it, if necessary. If the patient's comfort admits of it, he should be laid with the wound downwards, with a view to prevent accumulation of fluid in the pleura; and if there be two openings, as will be most frequently the case in rifle-ball wounds, one wound should be thus placed, and the upper be kept covered. In gun-shot wounds, closure of the parieties by adhesion is of course not to be looked for. The diet, beverages, and medicines must constantly have reference to the avoidance of inflammatory action; and should this occur, it must be combated on general principles.

If the presence of a ball within the cavity be ascertained, efforts should be made for its removal. But any attempt to determine where the ball has lodged should be made very cautiously, as more harm may result from the interference than from the lodgment of the foreign body. The existence of old adhesion will modify the effects of a penetrating wound, by excluding the track of the ball from the general pleural cavity, and may influence the result of the injury, especially if there be hemorrhage, or lodgment of foreign bodies, which may thus be brought within the sphere of removal more readily.

Wounds of the heart seldom come to the military surgeon's notice, as they ordinarily prove fatal on the battle-field.

Gun-shot Wounds of the Neck.—Gun-shot wounds of this region do not appear to be so fatal as might be anticipated from the large vessels and important canals leading to the thorax and abdomen, which at first sight appear to be so exposed and unprotected. In no region are so many examples offered of large vessels meeting, but escaping from balls in their passage, as in this, because the cause which operates elsewhere, ready mobility among long and yielding structures, exists in a greater degree in the neck than in any other part. When the large vessels happen to be divided, death must follow almost immediately. Superficial wounds of the neck offer no peculiarities. The larynx and trachea being the organs most prominent and most frequently injured, are those which chiefly attract the surgeon's notice in warfare.

Gun-shot Wounds of the Abodomen.—Gun-shot wounds of the abdomen are, like those of the chest, divided into *non-penetrating* and *penetrating*.

Non-penetrating may be either simple flesh-wounds, or may

be accompanied with fracture of some of the pelvic bones, or with injury to some of the contained viscera. In penetrating wounds the peritonæum only, or, together with it, one or more of the abdominal viscera, may be wounded; or, in comparatively rare cases, a viscus may be penetrated without the peritonæum being involved. It is in the regional cavity of the abdomen that the proportion of penetrating wounds is the greatest. The cranium, from its form, structure and coverings, serves as a strong defence even against gun-shot. The osseous, yet elastic and moveable ribs, the sternum, and muscular parieties, greatly protect the contents of the cavity which they enclose; but the extensively exposed surface of the abdomen, anteriorly and laterally, has no power of resistance to offer against a projectile directly impinging it; and when the important cavity is once pentrated by these means, death is the almost inevitable result. Even the changes of a favorable termination which may exist in wounds from other causes are generally wanting; and much of their treatment, such as the use of sutures, and other means to insure the apposition of cut edges, is inapplicable—from the parts to a certain distance being almost necessarily deprived of their vitality—to injuries from gun-shot wounds.

Non-penetrating Wounds.—If, although the viscera have been contused, the injury does not amount to being mortal, the patient should be subjected to perfect quiet, extreme abstinence, and, only when inflammation arises, to the necessary treatment for its control.

If the parieties have been much contused, abscess and sloughing may be expected, and a tendency to visceral protrusion must be afterwards guarded against.

When portions of the pelvic parieties are fractured by heavy projectiles, very protracted abscesses generally arise, connected with necrosed bone; and the vital powers of the patient are greatly tried by the necessary restraint and confinement. The great force by which these wounds must be produced, and the general contusion of the surrounding structures, cause a large proportion, sooner or later, to prove fatal, notwithstanding the peritoneal cavity may have escaped. Even apparently slight cases, as where a portion of the crest of the ilium is carried away by a shell, or ball lodged in one of the pelvic bones, often prove very tedious from the long-continued exfoliations and abscesses which result.

Penetrating Wounds.—A penetrating wound of the abdomen, whether viscera be wounded or not, is usually attended with a great amount of "shock." The prognosis will be extremely unfavorable if there is reason to fear the projectile has lodged in the cavity of the peritonæum; and in all cases the danger will be very great from inflammation of this serous investment. The liability to accumulation of blood in the cavity, from some vessel of the abdominal wall being involved in the wound, must not be forgotten.

When, in addition to the cavity being opened, viscera are penetrated, and death does not directly ensue from rupture of some of the longer arteries, the shock is not only very severe, but the collapse attending it is seldom recovered from up to the time of the fatal termination of the case. This is sometimes the only symptom which will enable the surgeon to diagnose that viscera are perforated. The mind remains clear, but prostration, oppressive anxiety, and restlessness, are intense, and, as peritonitis supervenes, pain, dyspnœa, diffused tenderness, irritability of the stomach, distension, and the other signs of this inflammation, are superadded. In ordinary wounds from musket-shot, scarcely any matter will escape from the opening in the parieties, the margin of which becomes quickly tumefied, but if any escape, it will probably indicate what viscus has been wounded. If the stomach has been penetrated, there will probably be vomiting of blood from the first. If the spleen or liver be wounded, death from hemorrhage is likely to follow quickly. In some instances patients, however, recover after gun-shot wounds involving these viscera.

If the small intestines have been perforated, and death follows soon after from peritonitis, the bowels usually remain unmoved, so that no evidence is offered of the nature of the wound from evacuations; but in any case of penetrating wound of the abdomen, when the opportunity is offered, steps should be taken to isolate and examine all evacuations which may follow. If the kidneys or bladder are penetrated, the escape of urine into the abdomen is almost a certain cause of fatal result. The latter viscus may, however, be penetrated without the peritoneal cavity being opened, and, as experience proves, the wound is by no means of a fatal character. Musket balls sometimes lodge in the bladder. In all such cases it is probable that the bladder has been pene-

trated at some part uncovered by the peritonæum, so that the cavity of the abdomen has not been opened; or, if otherwise, the foreign body has found its way in by ulceration, after adhesion has been established, and thus circumscribed the openings of communication. Small bodies may also pass into the bladder by the ureters.

When the abdominal parieties have been opened by shell or passage of large shot, protrusion of omentum and intestine will probably be one of the results. This does not always happen. Sometimes a wound caused by a large projectile, which was at first not penetrating, will indirectly become so, from the severe contusion and consequent sloughing, to such an extent as to denude the viscera. Curious instances are recorded, in which balls have passed directly through the abdomen, without perforating any important viscus, as proved by examination after death.

Gun-shot wounds of the colon, especially of the sigmoid flexure, appear to be less fatal, probably from structural causes, as well as circumstances of position, than wounds of the small intestines; they sometimes lead to fæcal fistula, and thus save life for a time.

Wounds of the Diaphragm.—Musket balls occasionally pass through the diaphragm; and Mr. Guthrie has remarked that these wounds, in instances where the patients survive, only become closed under rare and particular circumstances. Hence the danger of portions of some of the viscera of the abdomen, or the stomach or colon, passing into the chest, and thus forming diaphragmatic herniæ; and of these, eventually, from some cause becoming strangulated. The direction of the ball, hiccough, dyspnœa, accompanied with spasmodic inspiration and inflammatory signs, more particularly connected with the chest, will be the usual indications of such a wound; and in case of recovery, the risk of hernial protension and strangulation must be explained to the patient.

Should the strangulation occur, it can hardly be expecetd that division of the structure could be performed without the operation itself leading to equally certain fatal results.

Treatment.—In the general treatment of penetrating wounds of the abdomen, the surgeon can do little more than to soothe and relieve the patient by the administration of opiates, and to treat symptoms of inflammation, when they arise, on the

same principles as in all other cases. The usual directions to attempt agglutination of the opposite portions of peritonæum by favorable posture cannot generally be carried out, the attempts being defeated by the restlessness of the patient. The collapse which attends such injuries may be useful in checking hemorrhage; and the exhibition of stimulants is further contra-indicated by the risk of exciting too much reaction should the wound not prove directly fatal. If the wound be caused by grape-shot, or a piece of shell, and the intestine protrudes, it must be returned; if the intestine be wounded, sutures are inapplicable, as in an incised wound, without previously removing the contused edges. When the bladder is penetrated care must be taken to provide for the removal of the urine, either by an elastic catheter, or, if this cannot be retained, perineal incision.

Gun-shot Wounds of the Perinæum and Genito-urinary Organs.—From the position of these parts of the body, uncomplicated gun-shot wounds of them are comparatively rare. Perineal wounds are not unfrequently caused by shells bursting and projecting fragments upwards; but they are generally mixed with lesions of viscera of the pelvis, or fracture of its structure, or injuries about the upper parts of the thighs or buttocks.

Gun-shot Wounds of the Extremities.—Gun-shot wounds of the extremities divide themselves into flesh wounds and contusions, and those complicated with fracture of one or more bones. Flesh wounds may be simple, and these offer few peculiarities, whatever their site; or they may be accompanied with lesions to nerves, or blood-vessels, or both, and these usually increase in gravity in proportion as they approach the trunk.

When complicated with fracture, the lesion is usually rendered compound by the direct contact of the projectile with the bone injured; but the fracture is sometimes simple when caused by indirect projectiles, such as stones or splinters, or by spent balls. These injuries are liable to become further aggravated by the fracture extending into, or being complicated with, an opening of one of the joints. Joints may be contused or opened by projectiles without apparent lesion of any portion of the bones entering into their composition; but these are exceptions to the usual order of such cases from gun-shot.

Simple flesh wounds have already been referred to, both in respect to their nature and treatment in the commencement of this essay. It is in connexion with fractures of bones and their proper treatment that the interest of the surgeon is chiefly attracted in gun-shot wounds of the extremities. From the nature of the injuries to which bones are subjected by the modern weapons of war, together with the irreparable nature of the wound in the softer structures, except after a long process of suppuration and granulation, as well as from the usual circumstances of military life, it might be anticipated that difficulty would often arise in determining which of the double set of risks and evils—those attending amputation, and those connected with attempts to preserve the limb with a profitable result—would be least likely to prove disadvantageous to the patient. Experience in such injuries has established certain rules which are now generally acted upon; some still remain *sub judice*.

Upper Extremity.—Fractures of the bones of the arm are well known to be very much less dangerous than like injuries in the corresponding bones of the lower extremity. Unless extremely injured by a massive projectile, or longitudial comminution exists to a great extent, especially if also involving a joint, or the state of the patient's health be very unfavorable, attempts should always be made to preserve the upper extremity after a gun-shot wound.

In these injuries, when the bone is much splintered, the detached portions, and any fragments which are only retained by very partial periosteal connexions, should be removed; projecting spiculæ sawn or cut off; the wound being extended at the most dependent opening where two exist, or fresh incisions being made for this purpose, if necessary; light water dressing applied; the limb properly supported, and the case proceeded with as in cases of compound fractures from other causes. The same general rules also apply to the preserving as much of the hand as possible in gun-shot injuries.

If the shoulder or elbow joint be much injured, but the principal vessels have escaped, the articulating surfaces and broken portions should be excised. Care should be taken to see that the projectile has wholly passed out, or been removed. The results of excision practiced in the shoulder and elbow joints, especially the former, after gun-shot wounds, have been

exceedingly satisfactory. These operations present no peculiarities in the mode of performance or their after treatment, as compared with similar resections in civil practice.

Lower Extremity.—Gun-shot wounds of the lower extremity vary much more greatly in the gravity of their results, as well as in the treatment to be adopted, according to the part of the limb injured, than happens in those of the upper extremity. As a general rule, ordinary fractures below the knee, from rifle balls, should never cause primary amputation; while, excepting in certain special cases, in fractures above the knee, from rifle balls, amputation is held by most military surgeons to be a necessary measure. The special cases are gun-shot fractures of the upper third of the femur; especially when the hip-joint is implicated, for in these the danger attending amputation itself is so great that the question is still open whether the safety of the patient is best consulted by excision of the injured portion of the femur, by simple removal of detached fragments and trusting to natural efforts for union, or by resorting to amputation. The decision of the surgeon must generally rest upon the extent of injury to the surrounding structures, the condition of the patient, and other circumstances of each particular case. If the femoral artery and vein have been lacerated, any attempt to preserve the limb will certainly prove fatal.

Attention was specially directed in the late Crimean campaign, to the question of the proper treatment of these injuries, and expectations were generally held that the advanced experience in conservative surgery would lead to many such cases, terminating favorably, with preservation of the limb, which previously would have been subjected to amputation. Towards the latter part of the war, all the circumstances of the patients were as favorable for testing this practice as they had been in the various *emeutes* in Paris, with the advantages of immediate attention and all the appliances of the best hospitals close at hand. Yet, in the *Surgical History of the Campaign*, it is stated that only fourteen out of one hundred and seventy-four cases of compound fracture of the femur among the men, and five out of twenty among the officers, recovered without amputation being performed; that those selected for the experiment of preserving the limb were patients where the amount of injury done to the bone and soft parts was comparatively small; that where recovery ensued, it always proved

tedious, and the risks during a long course of treatment, numerous and grave; and that the proportion of recoveries would not appear even so large as the above, if the deaths of those who, after long treatment, were subjected to amputation as a last resource, were included. Amputations of the thigh, however, were very fatal in their results also, the recoveries being stated to be, among the men, in the upper third, 12 9-10; in the middle third, 40; in the lower third, 43 3-10 per cent. of cases treated. Among the officers the proportion was rather more favorable. But this per centage includes those cases in which attempts had been made to preserve the limb, and failure resulting, amputation was resorted to as a last chance of saving the patient, so that they ought to have been excluded from the lists of amputations, both primary and secondary, as commonly interpreted. On account of this comparatively indifferent success of amputation, resection of portions of the shaft of the femur was sometimes practised, but the records state that no success attended the experiment, every case, without exception, having proved fatal.

In considering the results of gun-shot fractures of the femur, the situation of the injury is a matter of great importance, whether as regards chances of recovery without or with amputation. Dr. Macleod, in his Notes, remarks that he has only been able to discover three cases in which recovery followed a compound fracture in the upper third of the femur without amputation. A case, however, was under the care of the writer, not included in the above, nor appearing in the official history of the war; and one, judging from the results described in Dr. Macleod's Notes, more fortunate in its issue than at least two of the number he mentions. Dr. Macleod says that, after many inquiries respecting cases of this nature in the hospitals of *other* armies engaged in the war, excepting one presented by Baron Larrey to the *Societe de Chirurgie* in 1857, he never could hear of any other but that of a Russian, whose greatly shattered and deformed limb he often examined. It united almost without treatment. Two cases of united fractures of the femur in the upper third have arrived from the late mutiny in India, and in both, Dr. Williamson records, a good and useful limb had resulted, one with shortening of one and a-half and the other three and a-half inches. Still more recently, M. Jules Roux, of the St. Maudrier Hospital, at Toulon, has given a list of no less than twenty-one cases

of gun-shot injuries of the upper third of the femur, which he had examined on their return from the Italian war of 1859.

The proportion of recoveries in amputations of the upper third of the femur in the Crimean war was under 13 per cent. Amputations at the hip-joint, both in the French and English armies, in all instances proved fatal. Resection of the upper part of the femur, including the head, and two inches below the small trochanter, was performed once, but the patient died from pyæmia. The operation in this instance was performed three weeks after the injury.

M. Legouest, in a recent essay in the *Memoirs of the Society of Surgeons*, at Paris, maintains that amputations at the hip-joint should be reserved for cases of fracture, with injury to the great vessels, and that when the vessels have escaped, resection should invariably be performed. He also inculcates, as a general principle, not to perform immediate *primary* amputation at the hip-joint in any case; but, even in the severest forms of injury, to postpone the operation as long as possible. For the *consecutive* results of gun-shot wounds, the operation presents a less unfavorable aspect than for immediate injuries. M. Jules Roux has recently, at Toulon, performed amputation at the hip-joint six times, for the consequences of wounds received during the war in Italy, and of these, four have been successful.

With regard to gun-shot fractures in the middle and lower third of the femur, the experience of the French and English armies in the Crimea has tended to confirm the doctrine of the older military surgeons, that many lives are lost which might be otherwise preserved, by trying to save limbs; and that, of the limbs preserved, many are little better than incumbrances to their possessors. In the late Italian battles, the practice of trying to save lower extremities, after comminuted fractures in these situations of the thigh, appears to have been abandoned. Eight cases of union, after compound gun-shot fractures of the femur in these situations, have, however, returned from the late mutiny in India, and this is a much larger proportion than was that of the recoveries from the Crimea. But wounds generally, when proper care is taken, heal more favorably in Southern latitudes, East or West, probably owing to the climate admitting of much more free access of fresh air, by day and night, to the patient,

that can be afforded, without inconvenience, in colder or more variable climates.

In fractures of the leg, where neither the knee or ankle-joints are implicated, the results of conservative attempts have been more favorable. Where the fracture is comminuted, and implicates the knee or ankle joint, opening the capsule, amputation is necessary. The knee-joint was once excised in the Crimea, but the patient died; as was the case in the only other instance where this operation is known to have been performed for gun-shot injury in the Schleswig-Holstein campaign. In the treatment of fractures of the leg, when it has been determined to seek union, the same remarks apply as those made above, in respect to fractures in the upper extremity. In wounds of the foot, it is especially necessary to remove, as early as possible, all the comminuted fragments of the bone injured, or tedious abscesses, and much pain and constitutional irritation, are likely to ensue.

CHLOROFORM AS AN ANÆSTHETIC.

Chloroform is a limpid, colorless, volatile, neuter liquid, having a bland, ethereal odor, and hot, aromatic, saccharine taste. It neither reddens nor bleaches litmus paper. It is but slightly soluble in water. Its specific gravity is 1.49 United States, 1.48 London, 1.496 Dublin. It boils at 142°. It is not inflammable, but renders the flame of an alcohol lamp yellow and fuliginous. It burns, however, with a smoky flame when mixed with an equal volume of alcohol. When pure, it has no action on potassium. It is scarcely acted on by sulphuric acid in the cold, but dissolves readily in alcohol and ether. A strong alcoholic solution is decomposed by abundance of water, the chloroform separating and subsiding, and the alcohol mixing with the water.

Impurities and Tests.—Chloroform is liable to contain alcohol and ether; both of which lessen its specific gravity. To determine the presence of impurities which have this effect on its density, Soubieran recommends that a drop of the suspected chloroform be added to a mixture of equal weights of concentrated sulphuric acid and water. Such an acid, when cold, will have the specific gravity of 1.38, and good chloroform, being of greater density, will sink in it.

M. Miahle has proposed the following test for the presence of alcohol: drop into distilled water a small quantity of the chloroform. If pure, it remains transparent at the bottom of the glass; but, if it contain even a small proportion of alcohol, the globules acquire a milky appearance. The most injurious impurities are the chlorinated pyrogenous oils. When the vapor of the oils is inspired, or even smelt, it causes, according to Dr. Gregory, distressing headache and sickness. These pyrogenous oils are detected by the action of pure and strong sulphuric acid. Pure chloroform, when mixed with an equal volume of the acid, does not color it; but, when contaminated with these oils, gives the acid a color, varying from yellow to reddish-brown, according to the amount of impurity present. In applying this test, several fluid ounces of chloroform should be used, as a slight change of color cannot be easily seen in a test tube. If the chloroform, thus contaminated, be poured upon the hand, it quickly evaporates, leaving the oily impurities, recognizable by their peculiar offensive smell, which is no longer covered by that of the chloroform. Pure chloroform, poured upon white paper, evaporates entirely without leaving any tache.

All new agents, that are presented for a place upon the primary list of the pharmacopœia, are viewed with prejudice and suspicion by the profession. In regard to chloroform, the feeling of distrust was very strong, whilst, on the other hand, the public eagerly seized upon and employed it, of course ignorantly and incautiously, and fatal results often followed. Every such case was gladly reported by the sensation press of the day, and thus, perhaps, we have more of the fatal cases resulting from the use of chloroform recorded, than from any other therapeutic agent. Very many more of the fatal cases were due to unskilfulness in its preparation and carelessness in testing for its impurities. The single case, cited in the British *Surgical History of the Campaign in the Crimea*, was due to these causes. But, perhaps, the greatest number of accidents have occurred with our own profession, and in cases, where we would least expect them,—in its administration for minor operations. A satisfactory explanation of this anomaly has been found in the fact that, in all these cases, the operator, in attempting to avoid danger by giving very little of the anæsthetic, has allowed "shock" to be pro-

duced, and death has been the result of it. If the anæsthetization had been pushed further, shock would have been entirely prevented. Other cases have occurred, with the profession, from inattention to the condition of the respiratory functions. We do not object to the attention paid to the pulse, but would insist upon greater being given to the respiration, since death results, in a majority of fatal cases, from obstruction to this latter function.

Some unfortunate results have been attributed to its employment in the most desperate cases, where, but for its aid the surgeon would have considered it madness to have operated. Still other, to want of special care in certain cases, as where there has been excessive hemorrhage, the chloroform being in such instances absorbed at once, owing to the emptiness of the veins; in cases of debility, where the accustomed stimulant is neglected before commencing or during the inhalation; and in that still larger class where it is not given to the required extent.

Whatever may be thought of it by civil practitioners, army surgeons cannot fail to give it their implicit confidence, when they consider the results of experience in its use, and the weight of authority demanding its employment. A computation has been made that one fatal case has occurred in every 16,000 in which it has been employed. Mr. Syme has used it in 5,000 cases with favorable results in every instance. Professor Simpson has administered it in over 15,000 cases without a single accident. In the Crimean war it was inhaled 25,000 times with no unfavorable result. Not a single case is reported from its employment in the late Italian war; and the same may be said of its use in our own service for nearly three years.

Professor Longmore says, "the complete applicability of chloroform, on the field, to injuries caused by gun-shot wounds as to all others in civil practice, is established among continental surgeons, and among a majority of British surgeons." Dr. Scrive, Chief of the French Medical Department of the East, writes, "of all the therapeutical means employed in the surgical art, none has been so efficient, and none has succeeded so well as chloroform; under no circumstances, in its employment with thousands, did it cause the slightest accident." Surgeon Major M. Armand says: "During the Italian war,

chloroform was as extensively used and was as harmless as in the Crimea." Macleod strongly recommends it; "for my own part, I have never had reason, for one moment, to doubt the unfailing good and universal applicability of chloroform in gun-shot injuries, *if it be properly administered*." Guthrie advises its use in the gravest of capital operations—amputation at the hip-joint. Deputy Inspector-General Alexander, of the British service, reports that "no operations whatever, of any consequence, has been performed in the Light Division without first placing the patient under the influence of chloroform, and in no single instance have either the medical officers of the division or myself seen any bad results follow, or had to reject its use, but quite the contrary. It should, therefore, be always employed, being careful only as to its purity and the mode of its administration.

Mode of Administration, &c.—A bed for the patient should be prepared, preferably in the open air, if the weather will permit, or in a room which may be quickly and freely ventilated by currents of fresh air. The patient, placed upon it, should have the head supported but by a single pillow, as it is very important that he be put and kept in the horizontal posture, and on no account be raised during the inhalation lest syncope supervene. The clothes should be loosed from about the neck, chest and abdomen, in order that the respiratory movements may be unimpeded; for the same reason the stomach should not be full, as it might interfere with the play of the diaphragm, which is the principle agent in respiration during the second stage of anæsthetisation. Vomiting would most likely result also, and might prove very inconvenient. The best time is, possibly, soon after the patient has digested a light, but nutritious meal—as the stomach is then empty and the patient strong. All special instruments of inhalation have been discarded, and a towel or napkin, folded into a cone, by having its corners turned down, is now almost universally employed for the purpose. The chloroform, about a drachm, is poured into this cone, and is held over the patient's mouth and nostrils, which should previously have been anointed. When the inhalation is about to commence, the surgeon should address a few kind and encouraging remarks to the patient, telling him that all that is required of him is to be still, and breathe naturally, and that the uncomfortable feeling of suffocation,

which is frequently experienced, will soon pass off; upon the assistants he should enjoin silence, and upon the administrator the strictest attention to the condition of the resperation, pulse and countenance. The administrator will now gradually bring the inhaler towards the patient's face, until it is within half an inch, and should never carry it further for fear of producing vesication, and excluding entirely the air. A proper admixture of air is always required in the inhalation of chloroform. It has been recommended, in the case of the feeble and timid, always to precede the inhalation by the administration of brandy, or brandy and a few drops of laudanum, and if the operation is long continued, to allow the patient to sufficiently recover to have it repeated. It has become an almost universal practice with surgeons in our own service to use the brandy in all cases before resorting to the anæsthetic. The practice is a safe one, and should not be omitted.

The phenomena produced by the anæsthetic have been divided into two stages: the first, one of excitement; the second, one of unconsciousness, insensibility and relaxation. The excitement is first shown upon the brain as the organ of intellection and sensation, when we have the mutterings, the wild eye, the cries, the exalted imagination, displaying themselves according to the peculiarities of the patient or the impressions made by circumstances. We have next the voluntary motions interested, as expressed by violent struggles, attempts to rise, and rigid contraction. The rigidity may extend to the muscles of the larynx, and thereby cause obstruction to the respiration. The reflex functions are the last to be influenced, as is exhibited by the spasmodic closure of the eye-lids upon the slightest touch. The actions of the nervous centres are, in the same regular gradation abolished, and we have unconsciousness, insensibility and relaxation of the voluntary muscles. The patient cannot be aroused, call him ever so loud, nor move, inflict what we may; the eye-lids no longer contract when the conjunction is touched,—the reflex functions are suspended, and the organic nerve centres alone are active. The inhalation has been carried as far as is either necessary or safe. It is maintained by the occasional repetition of the inhalation. Insensibility of the conjunctiva is perhaps the best test of perfect anæsthetisation, since by it we see that the reflex functions of the cerebro-spinal axis are suspended. There is,

however, a remarkable and most fortunate exception to this suspension—the nervous centres presiding over the lungs and heart are still active, though much less so than in the normal condition of the system. We find the pulse slow, small and weak, the respiration shallow and feeble; as they have only the organic acts to subserve, their force is diminished. In some instances, the stage of excitement is very transient, and the patient seems at once to fall into a quiet slumber; in other cases the first stage is much prolonged. During the whole time of administration the strictest attention should be paid to the respiration. Should obstruction come on in the first stage, as already noticed, it is probably due to the rigidity extending to the muscles of the larynx, and the effects are the same as those arising from spasm of the glottis. A suspension of the inhalation will allow the patient to respire fresh air, and, after a few inspirations, he will fall back unconscious and relaxed. Should the obstruction not thus readily yield, restorative means should be employed. When obstruction occurs in the second stage, it depends upon muscular relaxation, which allows the epiglottis to fall upon the glottis, and thus close the rima glottidis. Mr. Lister, however, says that this explanation is not satisfactory, and that the obstruction is caused by the arytæno-epiglottidean mucous membrane, which is carried forward and touches the base of the epiglottis.

The snoring respiration is due to the relaxation of the muscles of the soft palate, allowing the velum palate to flap and vibrate; whilst the stertorous breathing is laryngeal. Mr. Lister attributes this last to the vibrations of the mucous membrane upon the apices of the arytenoid cartilages.

When obstruction occurs in the second stage, we have most frequently stertorous breathing, though occasionally the respiratory movements take place silently. There is also lividity and profound alteration of the countenance, turgescence of the neck, dilitation of the pupil, and coolness of the general surface. If this condition continue, the respiratory movements soon cease, and then those of the heart. The treatment, to be efficacious in such extreme cases, must be very prompt. The inhalation must be suspended; the tongue, seized by the hook, tenaculum, forceps or fingers, must be drawn *forcibly* forwards, so as to clear the rima glottidis of the ob-

struction. Artificial respiration is to be instituted by either Marshall Hall's ready method, by Sylvester's, or by that of Prof. Campbell, of Georgia. Fresh, cold air is to be admitted to the patient, and water dashed upon his face and chest. Stimulating enemata are administered, and, if to be had at once, electricity is applied. In cases less grave, the dragging forwards of the tongue and the suspensson of the inhalation will be all that is required. The after effects of chloroform usually pass off as soon as the patient has had a good sleep.